Decision Support through Earth Science Research Results
Abstracts of selected proposals.
(NNH07ZDA001N-DEC)

NASA partners with national organizations and Federal agencies to extend NASA Earth Science research results into decision support tools to benefit U.S. and global citizens. This solicitation requested projects to integrate NASA Earth Science research results (e.g., spacecraft observations, model outputs) into decision support systems serving applications of national priority and to document improvements in the performance of the decision support systems.

NASA received 120 proposals in response to this solicitation – NASA selected 33 for awards, totaling approximately $23 million over the three-year life of the projects. Projects will aid the nation by demonstrating the capacity of operational organizations to use geoscience products and NASA Earth science research in their decision-making activities to benefit society. The selected projects directly support the objective stated in Sub-goal 3A of the 2006 NASA Strategic Plan to "Study Earth from space to advance scientific understanding and meet societal needs."

Additional information can be found at the NASA Applied Sciences Program website http://science.hq.nasa.gov/earth-sun/applications and http://nspires.nasaprs.com/.

Robert Adler/NASA Goddard Space Flight Center
Global Flood and Landslide Monitoring/Forecasting

Floods and associated rainfall-driven landslides account for the largest number of natural disasters and affect more people than any other types of natural disasters around the world. U.S. and international agencies and non-governmental organizations require accurate quantitative information about the occurrence (and near-term risk) of floods and landslides on a global basis in order to understand the human impact and plan mitigation activities. The proposers have recently developed a Global Hazard System (GHS) for floods and landslides which uses satellite observations and models to better understand, monitor and forecast these type of occurrences. The GHS utilizes the TRMM Multi-satellite Precipitation Analysis (TMPA) which combines information from ten satellites, all calibrated by rain estimates from the Tropical Rainfall Measuring Mission (TRMM). The GHS also uses remotely sensed land surface information (e.g., elevation from the Shuttle Radar Terrain Mission [SRTM], vegetation from MODIS) to establish the surface conditions critical for flood/landslide natural hazard occurrence. The remote sensing data are input into hydrological models, which provide quantitative estimates and forecasts of the hazardous events - on a global basis.

The primary goal of this proposal is to adapt, improve and transfer the GHS for use by the Agency for International Development (USAID) in their DSS supporting disaster management, response, and mitigation activities around the globe. The result will be much improved global information on floods and landslides and their impact on people

and property, and improved disaster response by USAID and other organizations. Regional applications will also be a focus, with evaluations of GHS information in Africa, Central America, and Bangladesh in order to assist in capacity building in these regions.

Letters of support from the World Meteorological Organization (WMO) Hydrology and Water Resources Department and the International Consortium on Landslides (ICL) attest to the value of this important effort.

Yoaz Bar-Sever/JPL
GPS-aided Real-Time Earthquake and Tsunami (GREAT) Alert System

Addressing the Disaster Management National Priority Area, we will exploit the increasingly available global and regional real-time GPS data from NASA's operational Global Differential GPS (GDGPS) System to enable more accurate and timely assessment of the magnitude and mechanism of large earthquakes, as well as the magnitude and direction of resulting tsunamis. The additional GPS-based information will be used to enhance the USGS operational system for post-earthquake damage assessment and emergency response, and, improve tsunami warnings by NOAA's Pacific Tsunami Warning Center (PTWC). Analysis herein shows that had this system been in place in 2004, it would have enabled alerts for the Sumatra tsunami within 15 minutes or less of its genesis, enough to save many lives. This system is also extremely cost-effective to implement operationally as indicated by the proposed ~$1M prototype. Both USGS and PTWC have expressed strong interest in this project and will support the development, benchmarking, and transition to operations of the enhanced system, investing their own resources.

Significant national and global societal benefits will follow from enhancing the existing disaster alert and management systems. The multi-national benefits from improved tsunami warning systems in the Pacific and elsewhere using GPS data satisfy the stated priority of this NRA to "enhance decision support systems for disaster management applications in an international context", as well as U.S. and NASA's commitments in support of GEO and USGEO.

All the underlying earth science models and GPS data types have been validated with actual data from past events. Using a rapid prototyping approach we will build a prototype GREAT Alert System within the first year, enhancing the current USGS and PTWC damage assessment and alert systems. We will refine it and perform quantitative benchmarking during the second year with input from our partner agencies, and pursue transition to operations during the third year.

Charon Birkett/University of Maryland
The Global Reservoir and Lake Monitoring System: Enhancing the USDA/FAS DSS with NASA, NRL and ESA Satellite Radar Altimeter Data

This proposal seeks funds to enhance and expand a satellite-based, near-real time, reservoir and lake water-level monitoring system. This system is on-line, operational, existing within the US Department of Agriculture (USDA) decision support system (DSS) through the cooperative USDA/NASA Global Agricultural Monitoring (GLAM) program. Current lake level products stem from the NASA/CNES TOPEX/Poseidon (archival 1992-2002), NASA/CNES Jason-1 (post 2002 and near real time) and the US Naval Research Lab's GFO (post 2000) missions. The primary user is the Office of Global Analysis (OGA) within the USDA Foreign Agricultural Service (FAS). The FAS utilize the products for irrigation potential considerations and as general indicators of drought and high-water (flood) conditions. The monitoring system has relevance to water resources management and agriculture efficiency applications at both the national and international level.

New objectives are:
1) To improve the quality and quantity of the current Jason-1 and GFO products.
2) To extend the 15year observations with near real time products derived from the follow-on NASA/CNES Jason-2 mission (launch, 2008).
3) To increase, by at least a factor of 5, the number of targets in the current system via the inclusion of ESA ERS-1, ERS-2 (1994-2002) and ENVISAT (near-real time) data. This greatly enhances the DSS, in particular by the inclusion of a large number of smaller reservoirs (100-300km2), and additionally provides a means to validate the current NASA/NRL products in regions where ground-based gauge data cannot be acquired.
4) With in-kind USDA support, continue the operational system with both NASA/CNES Jason-2 and ESA ENVISAT near real time products.
5) To provide an updated systems engineering report, which would include both an evaluation study and the results of the verification and validation exercises. The system will be benchmarked, stressing the overall value of the enhanced and expanded products to the USDA/FAS. An outline of the technical issues will be given and the original system requirements will be re-examined.

This proposal utilizes and enhances NASA Earth Science products in a USDA decision support tool that primarily supports agricultural efficiency. The proposed program will continue the collaborative effort between the USDA, ESSIC/University of Maryland, NASA/GSFC Hydrological Sciences Branch and SGT Inc.

Ximing Cai/University of Illinois
Developing Seasonal Predictive Capability for Drought Mitigation Decision Support System

The goal of this project is to develop the seasonal predictive capacity for the Drought Monitor-Decision Support System (DM-DSS) using Earth science models and satellite

products. The enhanced DM-DSS will assist society's response to a drought from a traditional "crisis management" scenario, which emphasizes emergency response, to a "risk management" approach, which places greater emphasis on preparedness planning and mitigation actions. Research objectives are as follows:

1. Incorporate into the existing DM-DSS the seasonal hydroclimatic predictions from a state-of-the-art Climate extension of Weather Research and Forecast (CWRF) model coupled with an advanced terrestrial hydrologic model, which assimilates real-time MODIS and GRACE data to improve the forecast/prediction.

2. Couple a decision analysis component with the predictive DM-DSS for optimal irrigation scheduling, which will provide end users more relevant decision support information at a lead time of up to one season.

3. Assess the quantitative and qualitative enhancements with NASA's Earth science models and remote sensing products by evaluating and comparing the baseline and benchmark levels of the predictive DM-DSS and relating them to stakeholders' perceived benefits. Both scientific testing and evaluation based on end users' surveys will be used for the benchmark development.

An integrated system solution (ISS) is designed to incorporate the NASA earth science model, Global Modeling and Assimilation Office (GMAO) coupled GCM, climate and hydrologic prediction models, and decision analysis modules into the DM-DSS. The multidisciplinary research team of PIs includes the primary developers of the DM-DSS and the prediction and decision analysis models, with collaboration from NASA researchers. A shared-vision approach will be adopted to involve national and local end users' organizations for benchmarking the enhanced DM-DSS. This project will first contribute to "Water Management" by extending Earth science research results for optimal irrigation scheduling during drought periods. It will also contribute to other national priorities such as "Agricultural Efficiency" and "Disaster Management". The outcomes of this project will directly contribute to the USGEO activity on drought by developing prototype tools for drought management under the framework of the National Integrated Drought Information System (NIDIS)

Gregory Carmichael/The University of Iowa
Dynamic Updating of Emissions by Systematic Integration of Bottom-Up Activities and Satellite-Based Top-Down Constraints to Support Air Quality Forecasting and Analysis

This proposal addresses the identified ROSES 2007 priority areas of air quality and public health. Specifically, in the air quality area the aspects of emissions inventories and forecasting are addressed in our proposal. These improved inventories will also support more accurate assessments of human and ecosystem health. This work builds upon the established unique research strengths of the research team in emission inventory development, chemical transport modeling, and satellite observations. These aspects will be combined to provide top-down constraints on emissions. The integration of these

efforts requires the use of chemical transport models to provide inverse modeling analyses. Top-down emissions have been combined with a bottom-up emission inventory to develop an improved a posteriori estimate of global and regional NOx emissions in basic research applications. However these studies were not designed as a systematic framework to ultimately provide an operational approach to rapid update of emissions, nor did they contain an active bottom-up emission estimate component, which is necessary to reflect and interpret emission changes (including those due to changes in legislation, technology, and economic factors). In this proposed research these activities, enhanced by closer interactions with the satellite community and informed by more recent participation in NASA field experiments (including INTEX A and B), will be utilized to develop and test a systematic analysis framework to provide rapid updates of emission inventories (i.e., updated on an annual basis). The impact of these improved inventories will be tested in air quality forecasting and human health assessment applications. Through this proposed research a systematic analysis framework to provide rapid updates of emission inventories will be developed and demonstrated in US and Asian applications, and will support several important international activities, including the EU task Force on Hemispheric Transport of Pollutants, among others.

Yi Chao/Jet Propulsion Laboratory
Impact of NASA Satellite Data and Models on
U.S. Coast Guard's Decision Support Tool for Search and Rescue in the Northeastern Pacific Ocean

The project goal is to provide improved real-time ocean surface current and wind observations as well as ocean circulation model forecasts with error estimates in the northeastern Pacific Ocean. The proposed work will enhance the input into coastal management Decision Support Tools (DSTs) used by the U.S. Coast Guard (USCG) for search and rescue (SAR). USCG has recently developed the Search and Rescue Optimal Planning System (SAROPS), which is the next generation DST for SAR planning. SAROPS is now operational at all 50 USCG Operation Centers. SAROPS has a central Environmental Data Server (EDS) to access a variety of sources of ocean surface current and surface wind products. The EDS is collecting and archiving the data products and then delivers parsed data sets to the SAROPS's users where Monte Carlo trajectory analysis is generated for the SAR cases.
This project will fully integrate NASA remote sensing measurements and assimilation model forecasting products into the USCG's DSTs for real-time operations by the end of our proposed three-year project. The general strategy for this project is to benchmark USCG SAROPS in year 1 during a proposed drifter field experiment in Prince William Sound, Alaska. We will develop the individual system components and demonstrate the system integration of various components in year 2, and to conduct another field test off the California coast in year 3 with an aim to quantify the impact of NASA Earth science results on the USCG DST SAROPS.
The management approach for this project is based on a well-established arrangement between federal agencies, academic institutions and private organizations. The broader significance and utility of this project will be realized by delivering a benchmark report and a transition plan linking NASA sponsored research to USCG SAROPS operations.

Robert Crabtree/Yellowstone Ecological Research Center
Development of RRSC Models for Use within the U.S. Fish and Wildlife Service's Strategic Habitat Conservation Framework

To maintain our nation's environmental health, we must continually improve our ability to manage our natural resources in ways that sustain ecological function and protect biodiversity. As a result, USFWS and USGS recently partnered to create a Strategic Habitat Conservation (SHC) Framework, with the goal of directing its management activities within a framework of strategic and effective decision-making. The SHC framework provides a new direction for existing decision support systems (DSSs) that rely on geospatial data, biological information, and predictive ecological models. While bringing NASA a new DSS partner (USFWS) under the proposed work, we will address numerous modeling deficiencies recognized by the SHC, including deficiencies in ecological forecasting. The overall goal of our proposed project is to integrate NASA Earth Science products and predictive species models into the USFWS DSS. We propose to improve the burgeoning DSS by creating web-deployed models with GIS-based outputs to (1) measure, monitor, and analyze the ecological conditions of focal area regions for conservation decision-making and predictive modeling capabilities, (2) implement a species-environment and demography modeling framework (called RRSC models) to predict environmental impacts on select focal species populations, and (3) establish a Species Forecasting System (SFS)-a web-based, user-friendly interface that allows end-users to answer what-if-scenarios. The models will be based on long-term USFWS population-level species datasets, NASA TOPS products, and other NASA Earth Science data products. The models will initially be developed for species in two pilot focal sites: the northern <?xml:namespace prefix = st1 ns = "urn:schemas-microsoft-com:office:smarttags" />Alaska and western Wyoming regions. To accomplish these goals, we have assembled an appropriate, experienced, and balanced team of co-PIs, co-Is, and a strategically crafted assessment team of USFWS, USGS, and NPS scientists for evaluation, benchmarking, and implementation of the NASA-enhanced US Fish and Wildlife Service decision support system.

William Crosson/USRA
Using NASA Remote Sensing Data in an Air Quality Modeling Decision Support System to Improve Land Surface Characterization and to Develop More Robust Performance Evaluation Methods

The U.S. Environmental Protection Agency (EPA) is responsible for protecting public health through development and enforcement of environmental standards. EPA's strategic plan defines 'Clean Air and Global Climate Change' as one of their five primary goals. It is pursuing this goal with the help of an air quality monitoring network and an array of analytical and physical models, organized within a computational framework referred to here as the Air Quality Management Decision Support System (AQMDSS). Realizing the central role that the AQMDSS plays in air quality management decisions of great socio-economic importance, EPA, in partnership with other federal agencies,

maintains an aggressive program towards continued improvement of the DSS. The characterization of the dynamic properties of the land surface plays an important role in determining the accuracy of air quality models. In the current AQMDSS, many dynamic features of the land surface are represented in very simplistic ways, with little seasonal variability or observational data. Data sets with improved spatial and temporal resolutions, such as those from NASA Earth Science mission sensors, have the potential to improve AQMDSS performance. The overarching goal of the proposed project, which addresses goals of NASA's Air Quality application of national priority, is to demonstrate the feasibility and to facilitate and broaden the use of remotely-sensed observations as an input to the AQMDSS, thereby supporting NASA's and EPA's goals. The expected improvements in the AQMDSS will lead to better air quality forecasts and facilitate decision-making for regulatory agencies and policy makers. This study also addresses two Air Quality national priority objectives: support EPA-developed tools for states and locals on regional haze, and improve land cover characterization in air quality models. We envision this project to demonstrate the usefulness of satellite observations, both as input to atmospheric models and for validation of their results.

Eric Danner/National Marine Fisheries Service
Improving Stream Temperature Predictions for River Water Decision Support Systems

When making decisions about water allocations, state and federal water project managers must consider the short-term and long-term needs of agriculture, urban users, hydroelectric production, and flood control. They are also required by the Endangered Species Act (ESA) to make sure their decisions do not jeopardize the continued existence of any endangered or threatened species. The National Marine Fisheries Service (NMFS) evaluates water project impacts on threatened and endangered salmonids and provides a decision on these impacts by issuing a Biological Opinion (BiOp). For water projects across the United Sates the NMFS BiOps (or similar processes by other federal agencies) are the decision support systems (DSS) for water allocation decisions with respect to endangered species.

The most recent BiOp for the Central Valley Project (CVP) in California was rejected by reviewers due to inadequate stream temperature and fish mortality models. These models are the current decisions support tools (DSTs) used in water allocation decisions, but are based on a monthly time step, which cannot take into account the fine scale temperature patterns that can be critical to salmonid survival. Thus NMFS is required to use models with finer spatiotemporal scales.

Generating stream temperature estimates in near real time, at fine spatiotemporal scales, and over large geographic areas is problematic using existing modeling approaches. We propose to use NASA Earth Sciences data coupled with ecosystem and statistical models to produce improved DTSs for stream temperature and fish mortality in the western U.S. The proposed system will include nowcasting and forecasting capabilities that will provide stream temperature and fish mortality estimates for every 1km of stream reach at 15 minute intervals. The proposed improvements to the existing DSS will allow for

substantially improved water allocation decisions by fisheries managers and water project managers.

Jill Engel-Cox/Battelle Memorial Institute
NASA Products to Enhance Energy Utility Load Forecasting

This proposal focuses on the application of high-resolution weather-related NASA Earth Science Data into key Decision Support Systems (DSS) used by energy utilities for short-term load forecasting. We will focus initially on an existing DSS maintained by NewEnergy Associates (NewEnergy), one of several major players in this private sector market. The end use (utility) customers of NewEnergy rely on these DSSs to balance supply and load on the electric grid or dispatch natural gas. The DSSs rely on weather data dictated by the spatial scales of ground-based stations, but are flexible enough to accept finer resolution data and model outputs uniquely provided by NASA, such as air temperature, relative humidity, and offshore winds. An End-User Group will be formed to provide input on load forecasting, discuss long-term planning as relevant, and guide transition of the results of this project from selected utilities to the nationwide energy utility community. The result of enhanced performance of these DSS is cost savings to residential, commercial, and industrial energy users, and energy conservation.

This proposal is responsive to the Energy Management application, and addresses supply and load forecasting as identified in the solicitation. This proposal will test the application of NASA Earth Science Data from a variety of sensors and model outputs, such as the short-term forecasts of surface temperature, relative humidity, and winds from the community-developed Weather Research and Forecast model initialized with Atmospheric Infrared Radiometer Spectrometer (AIRS) profile and Moderate Resolution Imaging Spectroradiometer (MODIS) surface information, and the MODIS-derived land and sea surface temperatures. A team of experts in utility forecasting software, utility operations, meteorology, and application of satellite data will participate as Principal and Co-investigators and Collaborators, from NASA Marshall Space Flight Center Short-term Prediction Research and Transition (SPoRT) Center, NASA Langley Research Center, Battelle, NewEnergy, Avista Utilities, and NationalFuel.

Wayne Esaias/NASA Goddard Space Flight Center
Improved Prediction of Africanized Honey Bee Distribution and Migration in the US and Honey Bee Climate Responses Using Satellite derived Land Cover Type and Phenological Data

Two extremely serious and highly publicized issues regarding honey bees are impacting agricultural pollination and crop and honey production in the US, in both commercial and private operations. These are a) the spreading presence of the invasive Africanized Honey Bee (AHB) which alarms the general public and disrupts pollination services and production of honey bee queens and replacement stock, and b) the spread of multiple pests and diseases within the managed honey bee populations (of which Colony Collapse Disorder (CCD) is but the most recent) that cause major loss of honey bee colonies.

Currently there is a lack of infrastructure to bring to bear broad-scale environmental and climate information from the NASA Earth Sciences programs on either of these issues. NASA environmental data derived from satellite observations and assimilation models could greatly improve the basis for understanding environmental aspects of both issues. Similar concerns exist with respect to the impact of environmental and climate change on native pollinators and the consequent impacts on terrestrial ecosystem functions (NAS, 2006).

We propose to augment an existing Decision Support System at USGS, by providing a range of NASA data sets and research model results tailored to study the spread of the invasive AHB, and the effects of land cover use and land cover change and climate change on the honey bee environment. These data from the Moderate Resolution Imaging Spectroradiometer (MODIS) on the Terra and Aqua satellites cover all of North America at ~weekly intervals and 1-5 kilometer spatial resolution. The products include vegetation indices, surface reflectance at multiple wavelengths, leaf area index, primary production, surface temperature, and ~weekly phenology metrics derived from these products that describe the time dependencies of plant characteristics like bud burst and blooming. New approaches in analysis of the satellite data and derived metrics will increase the relevance of the NASA data by addressing honey bee forage potential. We use hives on scales to monitor honey bee - forage plant interactions through changes in their weight. This very novel capability will be used to relate when nectar and pollen are available to the satellite derived vegetation data. Volunteer scale hive sampling is already underway as a prototype 2007 study in the Mid-Atlantic region via http://honeybeenet.gsfc.nasa.gov.

The DSS system is capable of producing maps at various time periods depicting likely habitats for the AHB, and of regions and times of pollen and nectar availability, through statistical manipulations of the data. We will work closely with a variety of decision makers at USDA, other federal agencies, state agencies, regional consortiums, and beekeeping organizations to improve and test the new capabilities provided by the DSS. This proposal is responsive to the National Applications Needs of Invasive Species, Agricultural Efficiency, and Ecological Forecasting. Through recent media attention to this important national problem and threat to US food production, increased public awareness, and the direct involvement of potentially thousands of beekeepers, this activity will greatly increase the appreciation of NASA observations and science results in the eye of the public.

Patrick Halpin/Duke University

Integrating Ocean Observing Data to Enhance Protected Species Spatial Decision Support Systems

Our ability to understand and mitigate adverse interactions with protected marine species is dependent on direct access to high-quality marine animal data, ocean observations, ecological models, and expert knowledge. The fusion of these diverse information streams into an integrated and spatially explicit decision support system is essential to meet the growing challenges of protected species and marine ecosystem-based management into the future.

Through an ongoing collaboration between the Marine Geospatial Ecology Lab at Duke University and NOAA's Southwest Fisheries Science Center (SWFSC) we are actively expanding the use of earth observing data in decision support tools for marine ecosystem and protected species management. This new effort will build on the existing Ocean Biogeographic Information System OBIS-SEAMAP program (Duke University) and the integrated marine mammal modeling and spatial decision support systems programs supported by the Strategic Environmental Research and Development Program (projects SI-1390 Duke University and SI-1391 NOAA-SWFSC).

We plan to significantly expand the scope, depth, and integration of remotely sensed data into our modeling and decision support system by: (1) incorporating and evaluating additional oceanographic measurements and indices for species-environment modeling; (2) implementing more robust automated workflows for processing earth observations for marine management use; and (3) expanding data dissemination and decision support functions using web services architectures. Our proposal will directly address priorities 5.1.6 Ecological Forecasting and 5.1.8 Coastal Management specified in the request for proposals. Our project will specifically improve an existing DSS for monitoring and assessing biodiversity at regional, national, and international scales as well as directly involve U.S. government agencies (NOAA, US-NAVY, ONR) and international organizations (OBIS, GBIF) with mandates for biodiversity monitoring and assessment. Our planned expansion of ocean observing data and analysis methods will provide a critical prototype for marine resource management decision systems development for the future.

Matthew Hansen/Geographic Information Science Center of Excellence
Integrating MODIS Crop Characterization Capabilities with AWiFS and Agricultural Survey Data to Improve the Accuracy and Timeliness of National Crop Acreage Forecasts Provided by the USDA NASS Cropland Data Layer Decision Support System

This Integrated Systems Solution project responds directly to the national priority application of agricultural efficiency. Specifically, the project employs innovative approaches to integrate Earth Science results to improve the timeliness and accuracy of the acreage estimation decision support system (DSS) run by USDA's National Agricultural Statistics Service (NASS). This will be achieved by incorporating data from the MODIS (MODerate Resolution Imaging Spectroradiometer) sensors on the Terra and Aqua spacecrafts and applying MODIS Land Science Team cover characterization methods and products to fulfill the goals of the NASS-DSS. Time-series MODIS data have the potential to improve current NASS crop classification capabilities in numerous ways, including the abilities to implement operational crop type characterizations, to produce crop cover products at earlier dates than currently possible, and to be integrated into higher spatial resolution data streams in a fusion approach. The NASS-DSS currently delivers Cropland Data Layers (CDL) and acreage indications of major commodities per state and county from multitemporal Indian Remote Sensing Advanced Wide Field Sensor (AWiFS) data calibrated by training data from the USDA/Farm Service Agency’s Common Land Unit (CLU) vector data sets. An intercomparison of the

current AWiFS/CLU trained methodology will be made with four alternative products: MODIS operational crop type maps, MODIS/CLU trained maps, integrated MODIS/AWiFS/CLU trained maps and MODIS-normalized AWiFS/CLU trained maps. Successful completion of the project will provide a necessary proof of concept for the use of remotely sensed data in a highly sensitive and extremely important operational environment by meeting the scope, timeliness, accuracy, and dependability required at the national level. Improvements in these areas will enhance a host of public, private and civil society decisions and applications worldwide that rely upon accurate and timely U.S. agricultural data.

Richard Houghton/Woods Hole Research Center
Carbon Management in the Northeastern U.S.: Assistance to RGGI (Regional Greenhouse Gas Initiative)

Ten states in the northeastern U.S. have formed the Regional Greenhouse Gas Initiative (RGGI) to reduce emissions of greenhouse gases (or sequester carbon) in the region, in part through management of land. This year RGGI will set up a "Regulatory Agency" that will serve as its central authority, and in time RGGI is anticipated to link with other such efforts in the western US, eastern Canada, and elsewhere. At present, RGGI allows afforestation as a carbon offset, but it will likely consider other management practices, depending on (1) the magnitude of potential emissions reduction (or sequestration) and (2) the demonstrated feasibility (accuracy and expense) of monitoring changes in management and/or carbon stocks. There is a critical need for spatial information on carbon storage.

We have assembled a team of investigators and collaborators with strong connections to NASA and RGGI that will enable us to work with the Regulatory Agency of RGGI toward the goal of developing a suite of carbon offset options. The information required by the Decision Support System defines three board objectives:

1. Characterization of the current situation: areas in different land covers, spatial distribution of carbon stocks, and current net sources and sinks of carbon.
2. Evaluation of the potential for future carbon sequestration (and release).
3. Design, implementation, and presentation to RGGI of an operational system for calculating current and potential sources and sinks of carbon from land-use change and land management. The system will include an evaluation of the trade-offs between cost and accuracy of the satellite- and model-based methodology for monitoring/verifying changes in carbon stocks for the region.

We will use NASA Earth System Science products (including maps of land cover, SRTM-based maps of aboveground forest biomass, Landsat-based maps of disturbance, and a carbon accounting model) to link current and future potential carbon stocks, as well as sources and sinks of carbon, to different land-management options.

Paul Houser/Institute of Global Environment and Society, Inc.
Benchmarking NASA Snow Research Results in NWS Hydrological Decision Support

Terrestrial snow processes are important for energy management, water management, and disaster management applications of national priority because of the timing of snowmelt and the subsequent fate of melted water play an extremely important role in the hydrological response of catchments. In the global water cycle, terrestrial snow is a dynamic fresh-water reservoir that stores precipitation and delays runoff. On average, over 60% of the northern hemisphere land surface has snow cover in midwinter, and over 30% of Earth's total land surface has seasonal snow (Robinson et al., 1993). NOAA has operational decision support tools (DST) in place to provide snow information to a wide variety of end-users and applications. NASA has conducted considerable research and developed advanced measurement and modeling tools to improve snow information. These tools are sufficiently mature to transfer them to NOAA's primary snow decision support framework, SNODAS.

This crosscutting Integrated Systems Solutions (ISS) project will therefore transfer, demonstrate and enable the use of snow-related NASA observational and modeling research results in NOAA's operational Snow Data Assimilation System (SNODAS) to improve water management, disaster management and agricultural efficiency decision support. The SNODAS is a major part of the National Snow Analyses (www.nohrsc.noaa.gov), a critically important Decision Support Tool (DST) which is widely used to make operational decisions on agricultural production, water resource management, flood, drought, weather and climate prediction, hazard mitigation and mobility assessment.

Daniel Irwin/NASA Marshal Space Flight Center
SERVIR Africa

The objective of this project is to initiate a SERVIR-like system utilizing NASA science research results for improved decision support for the continent of Africa. This project will be modeled after the highly successful NASA SERVIR system implemented in Central America (http://www.servir.net). We will partner with the US Agency for International Development (USAID) and the African Regional Centre for Mapping of Resources for Development (RCMRD) in Kenya, to investigate the benefits and implement the use of NASA research results. This project responds to the Applied Sciences Program national applications themes for Ecological Forecasting, Disaster Management, and Public Health. After a careful review of potential partners in Africa, we have chosen to work with RCMRD because of their extensive network of member countries in Africa, their strong connections to the international community, their expertise in remote sensing and geographical information systems, and their communications infrastructure including high speed internet and access to NASA's direct broadcast satellite data. Based on extensive dialogue with our RCMRD partner and the operational agencies in their network, we have chosen a primary and a secondary application: flooding and Rift Valley Fever (RVF). These two applications areas are

related in several of the environmental parameters necessary to monitor them: precipitation, topography, soil moisture and land cover.

We plan to use data from multiple NASA missions/sensors (SRTM, AMSR-E, TRMM, MODIS) and adapt existing NASA models including the NASA GSFC Global Hazard Model- Flood (Adler et al.), and the NASA GSFC Infectious Disease Ecoclimatic Link algorithm (Tucker et al.). The architecture for the SERVIR Africa system will be modular and will allow for future expansion to SERVIR Africa nodes in other areas of the continent. We will also coordinate this project with the operational SERVIR team at the CATHALAC facility in Panama to leverage existing capabilities including the physical infrastructure and training facility. The major results of this project will be a functioning SERVIR Africa node at RCMRD and improvements to the current decision making processes of the Kenya Flood Response System enabled by adopting the NASA products. An additional benefit of this project will be improved flood forecasting and monitoring capabilities at the operational SERVIR facility in Central America.

Richard Kiang/NASA Goddard Space Flight Center
Avian Influenza Risk Prediction in Southeast Asia and Early Warning of Pandemic Influenza

We propose to use NASA data, models and analysis techniques to enhance the decision capabilities concerning avian influenza (AI) and pandemic influenza risks at partner and end-user organizations. The DoD Global Emerging Infection Surveillance and Response System (GEIS) and the U.S. Naval Medical Research Unit-2 (NAMRU-2) are partner as well as end-user organizations.

Our specific objectives are to enhance the capabilities for assessing AI risks for poultry farms and humans, and the capabilities for early detection of pandemic influenza. In particular, we will generate the spatio-temporal risks of H5N1 outbreaks for selected districts in Indonesia and Laos, plus short-term and mid-term influenza-like illness (ILI) forecasts for selected regions in Indonesia, Laos and the United States.

We will use 14 NASA Earth sciences data products and model results. Neural network methods, textural-contextual classifier, and other analytic techniques currently used in a project funded by NASA Public Health Application Program will be adopted by this project for risk assessments.

Controlling AI outbreaks brings substantially more benefits to the society than just the farms where the outbreaks occur. It spares extensive culling, preserves the livelihood of small farmers, and protects food security and biodiversity. The world is presently in Phase 3 of the Pandemic Alert Period; reducing poultry infection will significantly reduce human infection. Most importantly, it reduces the likelihood of genetic reassortment in co-infection and the appearance of pandemic causing virus strains.

This proposal is related to NASA Strategic Sub-goal 3A -- study Earth from space to advance scientific understanding and meet societal needs. It contributes to the progress

in expanding and accelerating the realization of societal benefits from Earth system science. The proposed work is in the category of Public Health Applications, and is also of significance for the Disaster Management and Homeland Security Applications.

Dale Kiefer/University of Southern California
Pelagic Habitat Analysis Module (PHAM): Enhanced Decision Support for Pelagic Fisheries and Marine Sanctuaries

The Pelagic Habitat Analysis Module (PHAM) will provide an advanced information system that will enhance decision support systems currently at agencies managing pelagic fisheries and marine protected areas. PHAM will leverage streams of NASA research products from JPL and integrate this with multivariate datasets in support of agency marine resource management applications. PHAM will be a development of SSA's EASy marine GIS, that provides the computational and visualization tools to integrate scientific algorithms, satellite imagery, and field data for decision support, including fisheries oceanographic and tagging data. Proof of concept of enhanced DSS via PHAM will be provided by specific agency case study applications.

PHAM will provide software for automated processing of satellite imagery and related environmental information for improved definition of the habitat of pelagic species. Such processing includes algorithms for EOF analysis of satellite imagery (SST, color, and altimetry), SST-based analysis of data from electronically tagged species, and bio-optical analysis of ocean color imagery. The information on habitat provided by PHAM will be incorporated into models of stock recruitment and stock assessment by managers of marine fisheries at the Inter-American Tropical Tuna Commission (IATTC) and NOAA's Southwest Fisheries Science Center (SWFSC). IATTC is responsible for management of tuna stocks in the eastern Pacific Ocean, while scientists of the NMFS Fisheries Ecology Division help manage the fisheries of Pacific blue and shortfin mako sharks of the California Current. PHAM will provide managers of marine sanctuaries informatics resources for habitat analysis to augment their GIS-based decision support systems. These tools are used to make decisions regarding reserve design, human impacts to the sanctuary, the distribution and health of protected species, and the environmental conditions that affect these species. Our collaborators consist of the Channel Islands National Sanctuary and the Papahanaumokuakea Marine National Monument. Both sanctuaries will apply PHAM to better define the habitat of resident species as well as to help determine whether local ecological changes are linked to regional climatic shifts.

PHAM meets the national priorities of ecological forecasting and coastal management. It directly addresses the need to improve decision support for marine protection area management and marine fisheries assessment. In addition, PHAM directly address national calls for ecosystem-based management of living marine resources.

Greg Koeln/MDA Federal
Integrating NASA Earth Science Research into a Crop Insurance Decision Support System

InsuranceVision is a remarkable candidate for funding under this program because it is a financial DSS helping agricultural producers address severe losses to their crops yet it must incorporate land, climate and weather information because the success of an agricultural enterprise is heavily dependent on the environment. During InsuranceVision's development process, project team member AgrilLogic and the USDA Risk Management Agency (RMA) identified several improvements that will be implemented in this project to dramatically improve the usefulness of InsuranceVision. The improvements are in the land, weather and climate products utilized by the yield models, and the number and frequency of products available to producers. First, we are adding several new parameters including several satellite-based indices and obtaining higher resolution values of the current parameters. Second, we will offer more frequent updates to the forecasts and daily access to the agricultural specific observations to transform InsuranceVision from a once a season to an everyday useful DSS. The primary source of NASA data for the enhancements is the NASA Terrestrial Observation and Prediction System (TOPS). Our technical approach for this project is to: 1) Replace and enhance the existing component of the environmental input parameters and climate model segment of InsuranceVision with data from TOPS and other Earth science data sets; 2) Update the yield models using the improved inputs; and 3) Create a display tool that allows the producer to view daily measures of land condition, weather information, and updated yield forecasts. We will also create a hedging tool as an adjunct to the display tool so that based on their analysis of the near-real time data the producer can evaluate risk management options in addition to crop insurance such as using the commodity markets. The enhancements will allow producers to more efficiently and effectively plan their risk management strategies, providing more stability in their economic livelihood. As a result, we will be able to include a number of quantitative financial measurements as indicators of the success of this project. InsuranceVision is supported by the RMA and a number of producer groups including the National Corn Growers Association, National Sorghum Growers, and Western Growers Association.

Randal Koster/ NASA Goddard Space Flight Center
Development of a Robust Drought Index for Agricultural Applications

The proposed work serves, in effect, to translate a multitude of satellite-based observations into real-time estimates and seasonal predictions of agricultural drought, using an existing NASA seasonal forecasting system that employs state-of-the-art Earth system models and data assimilation algorithms. The work involves several tasks: (a) the assessment of predictability and drought forecast skill in the existing GSFC system, using retrospective forecasts; (b) a repeat of the previous task for the new GSFC seasonal forecast system coming online, for skill comparison analysis and to keep the contributions to the DSS current; (c) an observational analysis designed to ensure the physical realism of the forecast system's products; (d) the provision of real-time drought estimates to the U.S. Drought Monitor; and (e) the provision of seasonal drought

forecasts to the U.S. Drought Outlook. This proposal addresses the national priority areas of agricultural efficiency (through estimation and prediction of soil water content, critical to crop health), water management (through seasonal prediction of drought), and disaster management.

Stephen Lord/NCEP
Application of NASA Satellite Measurements and Aerosol Modeling Technology to Enhance the Nation's Environmental Forecasting Capability

This proposal outlines a partnership between NOAA and NASA to promote the use of NASA Earth science research results within NOAA decision support systems in order to improve the Nation's environmental forecasts that protect public health, life and property. This NOAA-NASA collaborative project will enable the capabilities of global aerosol forecasting and assimilation in NOAA operational global forecasting and assimilation system (GFS/GDAS), resulting from the adoption of a NASA aerosol modeling component (GOCART) and the utilization of NASA satellite-based aerosol measurements (CALIPSO, OMI, and MODIS). This project will be executed in close collaboration with the NASA-NOAA-DOD Joint Center for Satellite Data Assimilation, whose resources will be leveraged to improve the Sea Surface Temperature analyses. Time continuous, global aerosol concentrations from the GFS-GOCART system will provide more accurate particulate matter lateral boundary conditions for NOAA's National air quality forecast mission, improve the accuracy of medium-range weather prediction, and enable more accurate global SST analysis. Primary outputs of this project include (1) a prototype system that incorporates the NASA aerosol model and satellite measurements within the NOAA weather and air quality decision support tools and (2) benchmark reports that document the anticipated improvements in NOAA weather and air quality forecasts relative to the current baseline. An end-to-end work plan will be employed to ensure a timely and robust transition from NASA Earth science research results into NOAA operational applications.

Stephen Lord/NCEP
Development of a Planetary Boundary Layer and Atmospheric Stability Analysis for Homeland Security Applications

NOAA develops decision support systems to aid homeland security decision makers in the event that harmful toxic materials are released to the atmosphere. Specifically, NWS Forecast Offices and the NWS-NCEP Hydro-meteorological Prediction Center provide dispersion model forecasts driven by NCEP Numerical Weather Prediction (NWP) models to emergency response managers. In addition, NCEP NWP predictions are made available to the Department of Homeland Security Inter-Agency Modeling and Atmospheric Assessment Center and the DOD Defense Threats Reduction Agency to drive their dispersion models. The atmospheric planetary boundary layer (PBL) height is a critical parameter for dispersion decision support tools. Accurate assessment of boundary layer information at finer scales should improve the Nation's ability to assess the effects of a toxic release.

This proposal seeks to use recent NASA satellite technologies and surface based measurements to demonstrate a Real-Time Mesoscale Analysis (RTMA) of PBL information for use by plume dispersion modelers. Specifically, PBL height products derived from NASA GPS instruments aboard several satellites (COSMIC, GRACE, CHAMP) will be assimilated along in the NCEP 5 km RTMA. Ground based lidar measurements from the NASA MPLNET as well as CALIPSO will be used to evaluate the RTMA. We will also leverage the NOAA funded NCAS and other ground lidars for evaluation.
An additional dispersion related product, the atmospheric stability, will be computed using the existing RTMA analyses along with the proposed PBL products. The stability analysis can help emergency managers identify areas conducive for weak dispersion which would be vulnerable to high toxic pollutant concentrations if a release did occur. These results and user feedbacks will be compiled into a report that assesses the improved high resolution analysis on dispersion forecasts. An end-to-end work plan will be employed to outline the transition from NASA Earth Science research into NOAA applications.

John Mecikalski/University of Alabama in Huntsville
Application of Satellite Data to Enhance FAA Tactical Forecasts of Convective Initiation and Growth

Abstract: Application of Satellite Data to Enhance FAA Tactical Forecasts of Convective Initiation and Growth

This proposal requests funding to leverage NASA assets to continue optimizing a GOES convective initiation (CI) 0-1 hr nowcasting algorithm for performance across various "convective regime" types, and to transition the algorithm into a fielded FAA decision support system (DSS). The goal is to use satellite data to enhance predictability of the timing, location and growth rate of CI by more succinctly defining the characteristics of convective cloud development. The focus will be on nowcasting the first occurrence of >35 dBZ echoes within convective clouds, -- i.e. CI, across various thermodynamic environments that generate convection (i.e. "regimes"). The hypothesis is that this enhanced predictability of CI will lead to more accurate forecasts of the onset and intensity of hazardous convective-scale weather events that impact aviation across large sections of the U.S., as demonstrated through DSS forecasts. Examples of convective regime-types include dry mountainous environments, and humid tropical conditions. Currently, the GOES CI algorithm suffers from low predictive skill scores due to its lack of tuning to the different convective environments present across the continental U.S. at any given time.

NASA assets are optimizing the GOES-based CI method via the in-line convective-regime "training" information they provide via a multi-parameter database, statistical look-up table approach. In particular, NASA's CloudSat Cloud Profiling Radar (CPR), the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) Cloud-Aerosol Lidar, and the MODerate resolution Infrared Spectrometer (MODIS; aboard the Aqua satellite) observations (along with numerical weather prediction model

thermodynamic fields) improve the accuracy of the GOES CI algorithm as atmospheric conditions unique to various convective regimes are accounted for (i.e. cloud-top height, cloud-top temperature, and an estimate of cloud-top glaciation).

The CI algorithm will be incorporated into the Corridor Integrated Weather System (CIWS) DSS, which provides automated 0-2 hr convective weather forecasts in real-time to FAA decision makers. Through this effort, detections of early storm development and growth rates will be enhanced within CIWS. Specifically, satellites are the primary source of CI (pre-radar echo) information, representing a powerful capability to improve fine-scale convective-scale forecasts, and therefore the utility of the DSS.

FAA benchmark activities will quantify the value of the NASA satellite-enhanced CI algorithm within CIWS, through scoring software and evaluation of CIWS-user feedback. The satellite analysis will be validated for selected events with data from dual-polarimetric Doppler radar for improved microphysical observations (graupel, freezing altitudes and ice distributions), at the University of Alabama in Huntsville.

Christopher Mertens/NASA Langley Research Center
Space Weather Nowcasting of Atmospheric Ionizing Radiation for Aviation Safety

We propose to develop a prototype Nowcast of Atmospheric Ionizing Radiation for Aviation Safety (NAIRAS) model. The NAIRAS model combines observations of Earth's near-space and atmospheric variables with radiation environment and transport models to provide science results to decision support systems in the aviation area of national priority. The NAIRAS model will provide the first-ever, global, real-time, data-driven, atmospheric ionizing radiation dosimetry package for archiving and assessing biologically harmful radiation exposure levels at commercial airline altitudes. The source of biologically harmful (i.e., ionizing) atmospheric radiation is galactic cosmic rays (GCR), and the solar energetic particle events (SEP) that can accompany disturbances on the Sun's surface. The sources, composition, and energy-spectra of atmospheric ionizing radiation are subject to sources and variability of space weather phenomena. As a result, the NAIRAS model directly responds to the priority to provide space weather decision support tools related to radiation impacts on crew and passengers of long-range aircraft, as specified in this year's DECISIONS solicitation for the aviation national area of priority.

The NAIRAS model will enhance the performance of the decision support tools provided by the NOAA Space Environment Center (SEC), since this decision support system currently does not monitor or estimate the ionizing radiation present in the atmosphere at commercial airline altitudes. The end-user communities that will benefit from the NAIRAS model are the commercial airline industry (airline corporations and aircrew professional associations), the FAA, NIOSH, and NOAA/SEC. Results from the NAIRAS model will provide a tool for its end-user organizations to develop policy and procedures for mitigating biologically harmful radiation exposure and aircrew career planning - especially during SEP events. NAIRAS results will also aid in the formulation of recommended aircrew annual and career radiation dose limits, and will enhance

epidemiological studies conducted to better understand the biological effects of atmospheric ionizing radiation on passengers and aircrew.

Observations are utilized from the ground (neutron monitors), from the atmosphere (the METO analysis), and from space (NASA/ACE and NOAA/GOES). Dose rates are simulated using the AIR (Atmospheric Ionizing Radiation) model, which is a validated parametric model, and the HZETRN (High Charge and Energy Transport) model, which is a state-of-the-art, physics-based galactic cosmic ray (GCR) and SEP radiation transport code. The physics-based CMIT (Coupled Magnetosphere-Ionosphere-Thermosphere) and SEP-trajectory models are employed to benchmark the magnetosphere-ionosphere-thermosphere response to GCR and SEP events to facilitate the transition of research space radiation environment models to real-time operational usage.

Stanley Morain/University of New Mexico
Adding NASA Earth Science Results to EPHTN via the NM/EPHT System

This project bridges individual health and community health by forecasting atmospheric ozone, dust and other aerosols that trigger asthmatic responses or myocardial infarction; and, by enhancing the New Mexico Environmental Public Health Tracking System's ability to prepare for, and to provide early warning to, populations at risk. The three primary tasks are to:
(1) assimilate products from NASA satellite sensors into EPA's Community Multi-scale Air Quality (CMAQ) model and the Dust Regional Atmospheric Model (DREAM). For human health applications, these include (a) bi-monthly land cover characterizations derived from MODIS data that are available daily from both the TERRA and AQUA observatories; (b) MODIS aerosol optical depth measurements from TERRA and AQUA; and, (c) aerosol profile products from CALIPSO and GLORY;
(2) verify and validate model outputs and assess improvements to ozone, dust, and other aerosol forecasts;
(3) Enhance EPHTS and EPHTN decision support systems with model outputs and forecasts.

Bi-monthly inputs of land cover that includes a barren land category will help CMAQ and DREAM to simulate desert dust production and biogenically emitted chemicals such as isoprene and monoterpenes. In addition, satellite aerosol measurements will help set more realistic initial and boundary conditions for the models. This project engineers a new course for incorporating satellite measurements of aerosols and land cover change data into forecast models that support health decisions. To test the two tasks and transition outputs to EPHTS and EPHTN, the project will collaborate with New Mexico's Department of Health and CDC's Environmental Public Health Tracking Program.

Benefits are: (1) incorporating Earth science results for health care and decision making in respiratory disease diagnoses and surveillance; (2) improving cost effectiveness of inpatient health care by providing 36-48 hour forecasts that assist decisions for hospital staffing, diagnosis, and treatment; and, (3) expanding the knowledge gained in earlier air quality/health efforts to an atmospheric chemistry model in the PM2.5 and finer size ranges.

Mutlu Ozdogan/University of Wisconsin

Introducing Remotely Sensed Irrigation Information into the USDA FAS Decision Support System

This project aims to develop a high resolution, seasonal, and up-to-date information on irrigation extent and acreage from NASA Earth Science observations to enhance USDA Foreign Agriculture Service (FAS) Decision Support System. The primary goal of FAS is to improve foreign market access for U.S. agricultural products by providing accurate global crop production, supply, and demand estimates that are of primary national importance. To improve these estimates the International Production Assessment unit of FAS now requires the capability to rapidly separate and delineate irrigated and dryland agriculture every crop season. The capability to accurately identify and estimate irrigated agriculture is especially important for countries where irrigated agriculture plays a dominant role because yields on irrigated lands can be nearly twice or more than those on dryland farmed areas. However, national-(and occasionally)subnational-level information on irrigated acreage of major crops is not routinely available and even if available, this information often tends to be flawed, outdated or simply lacking to be useful in seasonal crop production estimates. The primary objective of this project is to fill this gap in each of the nine FAS mandate regions by using NASA Earth Science measurements and research results.

In the first part of the study, new satellite remote sensing data sets provided by MODIS will be combined within non-parametric, tree-based classification models to provide binary irrigation information at continental scales. In this effort, historical and current modeled soil moisture data, cropland masks, historical and current spectral and temporal vegetation indices that are specifically sensitive to irrigation, and training(learning)examples obtained from medium resolution(< 100 meters)remotely sensed data will provide the primary inputs to the classification algorithm. In the second part, classification results of AWiFS data will be merged with a priori knowledge on irrigation presence obtained in the first part to identify and map irrigated areas at greater spatial detail.

Expected results and products from this research include:(1)automatic methods to estimate global extent and acreage of irrigation through remotely sensed observations that are also applicable to future NASA and/or commercial missions/sensors;(2)integration of NASA Earth science research results into the USDA-FAS decision support system for applications of national priority by providing accurate and timely information on the location and extent of irrigated croplands in each of the nine FAS mandate areas;(3)improvement of a DSS specifically developed to disseminate global crop production related information broadly across the nation for a large national benefit;(4)direct contribution to NASA’s Agricultural Efficiency applications area through the direct use of NASA's investments in remote sensing;and(5)integration of commercial remote sensing and geospatial information with NASA Earth Science measurements to improve a nationally important DSS.

Kenneth Pickering/NASA Goddard Space Flight Center
Monitoring Air Quality Effects of Anthropogenic Emissions Reductions and Estimating Emissions from Natural Sources

We propose a program of work that will enhance applications of EPA's Community Multiscale Air Quality (CMAQ) Model, which will be considered as the Decision Support Tool in this application of NASA Earth Science Research Results. We will enhance the application of CMAQ through linkages with NASA satellite data products and with NASA-generated model algorithms. CMAQ is run for operational air quality forecasts by NOAA, run by EPA for national air quality assessments, and run by state agencies for air quality planning. In all applications of CMAQ accurate emissions inventories are necessary for making accurate air quality estimates. Natural sources of NOx (soil and lightning) are currently either crudely represented or not included in inventories used in CMAQ. The air quality impacts of large changes in power plant NOx emissions that have been mandated under EPA's SIP Call have been estimated with national assessments run with CMAQ. However, EPA is required to demonstrate the resulting improvement in air quality through monitoring activities.

We anticipate that tropospheric NO2 from the OMI instrument on NASA's Aura satellite can be used in conjunction with CMAQ to both refine estimates of natural source emissions of NOx and to monitor air quality improvements associated with anthropogenic emissions reductions. We will begin by adapting an existing algorithm for lightning NOx emissions for use in CMAQ. We have developed this algorithm under previous NASA funding for the Global Modeling Initiative (GMI). The algorithm ensures that lightning emissions are input to the model in the same locations and times for which the model contains deep convection, and that the emissions are input using a realistic vertical profile. Testing will first be conducted using observations of lightning flash rates from the National Lightning Detection Network and the OTD/LIS satellite-derived lightning climatology. Resulting NOx mixing ratios from CMAQ will be evaluated against aircraft measurements from the NASA Tropospheric Chemistry Program's INTEX-NA experiment in the summer of 2004. The longer-term evaluation of the lightning emissions will be conducted using the OMI data. Soil NO emissions are likely underestimated in current emissions inventories used in CMAQ. OMI NO2 data from regions of cropland with low population density and distant from major point sources will be analyzed, and soil emissions will be adjusted in CMAQ simulations such that the model matches the tropospheric column NO2 from OMI.

Substantial NOx emissions reductions have been taking place at eastern and central US electrical generating plants since 2003. Much of the power plant emissions are transported either in the upper portion of the boundary layer or above the boundary layer top. Therefore, satellite data would appear to be the tool that would allow more comprehensive assessment of the results of the emission reductions than would surface monitoring alone. EPA has begun an Advanced Monitoring Initiative project along these lines using SCIAMACHY NO2 data. We will contribute to the EPA activity by employing a methodology for use of the OMI data in examining the air quality impacts of

the emissions reductions. The method will consist of using CMAQ simulations to define regions of influence downwind of the sources undergoing emissions reductions. OMI data will be analyzed in the regions of influence defined by CMAQ for time periods before and after emission reduction occurs, such that we can determine the magnitude of improvement in air quality. EPA-mandated Tier II mobile source NOx emissions reductions of 5% per year on new vehicles began in 2002 and will continue to 2010. We will use the same technique designed above for employing OMI data to evaluate air quality improvements in major metropolitan areas (e.g., Baltimore-Washington area and others) resulting from these motor vehicle emissions reductions.

Jorge Pinzon/Science System and Applications, Inc (SSAI)
Predicting Zoonotic Hemorrhagic Fever Events in Sub-Saharan Africa using NASA Earth Science Data for DoD - Global Emerging Infections Surveillance and Response System

Emerging infectious diseases are increasingly a global and regional security issue with the capacity to have serious human health and economic impacts, and to harm U.S. interests abroad by destabilizing key institutions. Through the integration of NASA Earth Science results into the DoD-Global Emerging Infectious Surveillance & Response System (DoD-GEIS), this proposal aims at complementing GEIS with a systematic method of monitoring and forecasting environmental and climatic risk factors associated with emerging infectious diseases, including hemorrhagic fever zoonoses (filovirus and Rift Valley fever.) This proposal builds on an innovative eco-climatic monitoring algorithm that quantitatively assesses environmental and climatic risk factors that could lead to the occurrence of a vector-borne disease and provides risk maps that highlight areas where targeted surveillance should be implemented. We aim to provide monthly environmental risk maps for zoonoses, with focus on Ebola, Marburg filoviruses and Rift Valley fever in Africa by integrating information from MODIS on Terra and Aqua, TRMM data, SRTM, and as well as simulated products from NPP and GPM upcoming missions. GEIS is a unique resource for global affairs and the only U.S. entity devoted to infectious disease globally that has broad-based laboratory capacities in overseas settings. By supplementing DoD-GEIS with NASA-derived environmental risk maps, we seek to support and enhance: 1) GEIS efforts toward improving surveillance systems as crucial to preventing, detecting and containing emerging infectious that threaten U.S. military personnel, their families, and national security, and 2) GEIS overseas military research units with their service to host country counterparts, World Health Organization, and the Food and Agriculture Organization of the United Nations to improve local epidemiological capabilities. We seek to support the NASA Public Health program in their focus areas of infectious disease, and Homeland Security program for preparedness, response, and mitigation

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Matthew Rodell/NASA Goddard Space Flight Center
Integrating Enhanced GRACE Water Storage Data into the U.S. and North American Drought Monitors

Mapping the onset and severity of drought is of critical national importance. The Western Governor's Association, in proposing a National Integrated Drought Information System (NIDIS), has recognized the U.S. and North American Drought Monitors (USDM; NADM) as important tools for minimizing drought impacts, yet both are limited by the inadequacy of current soil moisture and groundwater observation networks.

NASA's Gravity Recovery and Climate Experiment (GRACE) satellites are unique in their ability to measure variations in water stored at all levels above and within the land surface. However, GRACE is currently underutilized for hydrological applications due to the coarseness of the products: monthly, >150,000 km2, and unstratified. The Catchment Land Surface Model (CLSM) simulates groundwater, soil moisture, and snow water storage, using physical parameterizations of hydrological processes. While its resolution is high, accuracy is limited by input data quality and simplifications required for computational efficiency. Recently, three of the investigators developed a data assimilation scheme (DAS) to disaggregate GRACE observations spatially and temporally within CLSM, with remarkable results.

We propose to integrate GRACE-DAS products into the USDM and NADM. Assimilated groundwater and soil moisture fields will be systematically incorporated into the objective blends which constitute DM baselines. The original objective blends, serving as benchmarks, will be compared with GRACE-integrating versions. We will refine the GRACE-DAS configuration and optimize the objective blend weighting using several a posteriori measures of drought severity. These metrics and stakeholder feedback will be used to quantify improvement in the USDM and NADM due to inclusion of GRACE-DAS fields.

The proposed project will benefit the Water Resources, Agricultural Efficiency, and Disaster Management national application areas. In particular, it will reduce uncertainty in the management of surface and aquifer water resources through its novel use of GRACE data for mapping drought severity.

Mitchell Roffer/Roffer's Ocean Fishing Forecasting Service, Inc.
Improving The NOAA NMFS and ICCAT Atlantic Bluefin Tuna Fisheries Management Decision Support System

This research focuses on extending Earth science research results to decision support systems in the Ecological Forecasting national priority area. The activity seeks to improve the existing National Oceanic and Atmospheric Administration’s (NOAA) National Marine Fisheries Service (NMFS) decision making system for population assessment and management of Atlantic bluefin tuna (Thunnus thynnus thynnus). The research team is a multi-sector and multi-disciplinary team composed of government

(NOAA_NMFS), academic (University of South Florida Institute for Marine Remote Sensing) and commercial (Roffer's Ocean Fishing Forecasting Service, Inc.).
The goal is to reduce the variance in the estimates of adult Atlantic bluefin tuna spawning stock abundance in the Gulf of Mexico (GOM) through the development of spawning site habitat classification and catchability indices of the larvae. These will be derived from the innovative use of several earth orbiting satellites. The estimates of the adult spawning biomass are critical in understanding changes in the population size used to derive international and national fisheries management strategies and allocations. Accurate estimates of adult population size are critical in understanding the population dynamics of an internationally important fish that supports commercial and recreational fisheries.
Functional links have been established between climate variability, regional-scale oceanographic processes and recruitment to fisheries. The exact mechanisms driving many of these links remain poorly understood and influences on the transport and survival of pelagic larval stages are likely to be significant. We propose to analyze these data in combination to develop a time-series of enhanced biological and oceanographic indicators for the GOM fisheries. While the catchability indices will be used in developing indices for the population analyses, the habitat classification will aid in developing models forecasting where concentrations of larvae are likely to occur leading to an adaptive sampling strategy.

Uma Shankar/University of North Carolina
Improving an Air Quality Decision Support System through the Integration of Satellite Data with Ground-based, Modeled, and Emissions Data

Acquiring, organizing, and analyzing the datasets necessary for planners to thoroughly evaluate air quality and accurately trace emissions sources is a laborious and costly process that strains already-limited state and federal resources. Even after such data have been consolidated and analyzed, employing them synergistically to design effective emissions control strategies is a complex and time-consuming task, requiring expensive, disparate, and hard-to-use tools, with results that are difficult to integrate and intercompare. To address these issues and improve air quality decision-making by local, regional, and national planners, this proposal seeks to integrate key NASA satellite data to augment the databases, improve the models, and enhance the analytical capabilities of the VIEWS/TSS decision support system (DSS) currently used by the four Federal Land Managers (FLMs), the five EPA Regional Planning Organizations (RPOs), and state, tribal, and local agencies.

These enhancements will be effected by using data from Aura, CALIPSO, Terra, and Aqua, and integrating statistical analysis tools to (a) improve methods for identifying pollutant sources and their respective contributions to visibility impairment in Federal Class I Areas, (b) provide fire activity data to calibrate a stochastic fire model and improve future-year fire emissions estimates, (c) facilitate interpretative analyses of ground-based, modeled, and emissions data, and (d) support control strategy development. End user requirements will be gathered from representatives at NPS, EPA, WRAP, and the state of North Carolina, and resulting enhancements will be evaluated by

examining website statistics and end user feedback to determine the volume and type of NASA data interactions, the targets of user searches and navigation, and the nature of satellite-enhanced analyses incorporated into user emissions-control strategies. A final demonstration will compare baseline and enhanced DSS performance in assessing visibility in a selected region encompassing several Federal Class I Areas for base- and future-year periods of air quality simulation.

Tristram West/Oak Ridge National Laboratory
Modeling and Mapping Land Management and Net Carbon Emissions: Decision Support for Biofuels and Carbon Management on US Agricultural Lands

The President's Biofuel Initiative of 2006 mandates a 15% replacement of current gasoline consumption with biofuels by 2017. Critical issues surrounding this Initiative include knowing the current and future amount of available biomass feedstocks, the sustainability of producing bioenergy crops, the impact of this production on the carbon cycle, and the economics associated with adoption of bioenergy crops.

An agricultural economics model, POLYSYS, has historically been funded and used by DOE to predict adoption rates of bioenergy crops, and by USDA to predict changes in land management. Incentives for adopting alternative cropping practices and bioenergy crops can have a substantial impact on carbon sources, sinks, and net carbon-equivalent emissions in the US. With previous funding from NASA, we integrated data sets and modeling components on land use, soil carbon, energy use, and greenhouse gas emissions with changes in land management predicted by POLYSYS. The newly integrated Decision Support System (DSS) is a spatially explicit framework capable of comprehensive full carbon accounting (FCA) for agricultural lands and is referred to as POLYSYS-FCA.

Under this solicitation, we propose to (a) improve specific components of POLYSYS-FCA, and (b) partner with DOE and USDA to provide decision support for issues involving bioenergy crop production, carbon management, energy use, land-use change, and net carbon emissions. We specifically propose to employ a method for error propagation; integrate carbon dynamics associated with bioenergy crops; integrate an existing soil erosion model; improve on our use of NASA research results; and complete estimates of net carbon-equivalent emissions from agricultural lands in the North American Carbon Program's Mid-Continent Intensive region. NASA-related remote sensing products will be used in several components of the DSS.

John Williams/National Center for Atmospheric Research
Global Atmospheric Turbulence Decision Support System for Aviation

Applications of National Priority: Aviation, Energy Management, Air Quality

Turbulence is widely recognized as the leading cause of injuries to flight attendants and passengers on commercial air carriers. However, while a state-of-the-art, automated

CONUS Graphical Turbulence Guidance (GTG) system has been developed by the Federal Aviation Administration's Aviation Weather Research Program and deployed at the National Weather Service's Aviation Weather Center, no analogous system currently exists to support the World Area Forecast Center, the agency responsible for supplying aviation weather products along oceanic and international routes. This proposal represents an opportunity to use NASA assets and Earth science research results to develop a Global GTG system to augment and enhance the current World Area Forecast System (WAFS) DSS in accordance with US national interests and treaty obligations. The results will be improved air traffic safety and efficiency with concomitant benefits to passengers and airlines via fuel savings, improved air quality, fewer injury claims, reduced delays, and lower aircraft maintenance costs.

The Global GTG system will leverage previous and current NASA- and FAA-funded research and development results in providing fully-automated, rapid-update global turbulence nowcasts and forecasts. It will employ Global Forecast System (GFS) model output and data from NASA satellite and other national and international assets to provide comprehensive assessments of turbulence from clear-air, mountain wave, and convective sources. In addition to supporting the production of more timely and accurate WAFS SIGWX charts and SIGMETs, Global GTG will directly support the Next-Generation Air Transportation System by producing probabilistic 4-D global weather grids as mandated by the Joint Planning and Development Office. Under this proposal, Global GTG's contribution to the WAFS DSS for turbulence will be quantitatively and qualitatively evaluated via a demonstration involving web-based graphical dissemination and flight deck displays of real-time turbulence maps on select international United Airlines flights.